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TOMATO PROPAGATION

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Growing Plants and Transplanting
or
Direct Field Seeding and Thinning

THE COLLEGE OF AGRICULTURE
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may be grown in specially prepared beds, for transplanting in the field, or they may be grown from seed planted directly in the field.

SEEDING DIRECTLY IN THE FIELD where the crop is to be grown has been practiced in Imperial and Coachella valleys for years. It has possibilities for the market crop in other areas, and already is being widely accepted for canning tomatoes. This method of tomato propagation is discussed in detail starting on page 24 of this circular.

GROWING PLANTS IN SPECIAL BEDS and transplanting into fields is still the most common practice for much of the market and canning crops.

For the most part tomato diseases must be controlled or avoided while growing the plants and selecting the fields. Once the plants are set out in the field little can be done with control measures except perhaps for a few foliage diseases which occasionally develop. In importing plants from other areas tomato growers should carefully guard against the introduction of new diseases or pests.

The important aims of a plant grower should be to produce short, stocky, well hardened, disease free plants. Success usually depends on:

- Using good seed that is known to be disease free, and taking precautions to keep it that way.
- Locating seed and plant beds on soil that is free of diseases, weeds and pests.
- Controlling damping-off.
- Giving plants proper temperatures, ventilation, moisture, and spacing.
- Culling out weak plants.
- Avoiding the use of tobacco when working with plants.
- Avoiding the topping of plants.

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GROWING PLANTS FOR TRANSPLANTING

Good tomato plants can be produced satisfactorily in many ways. The type of plant bed to use and the methods and cultural operations to follow depend on several factors such as the time of year plants are desired, prevailing soil and air temperatures during the plant growing period, the frost hazard and the quantity of plants needed.

CHOICE OF METHODS

TYPES OF PLANT BEDS

The following types of beds are those most commonly used for starting tomato plants and getting them to a point where they can be transplanted into the field where they will eventually grow.

Cold Frames are outdoor frame structures that are usually covered with muslin or light canvas. The muslin covers afford protection against light frosts, shed rain and trap some heat within the frame. They cut out a considerable amount of sunlight and in this respect are much inferior to glass in heating the soil and in shading the plants.

Hot Beds are similar to cold frames in construction, are covered with muslin, canvas or glass and are provided heat artificially in addition to the sun.

Tomato plants are also produced in open plant beds, in open field beds and in greenhouses.

The term *seed beds* refers to small special cold frames or hot beds that are used for germinating the seed and growing the seedlings to a size that can be moved to larger plant beds.

COMMON METHODS OF PLANT GROWING

Direct-Seeded Cold Frame Method. The seed is planted in rows or broadcast thinly in beds where the plants will remain until they are ready to transplant into the field. Some thinning of the young seedlings usually is required to give a spacing that will permit the development of stocky plants. Row planting has the advantage over broadcasting the seed because of easier thinning and weeding. The rate of seeding should be carefully regulated as overseeding greatly increases the cost of producing plants because of the extra thinning. The majority of the home grown plants for the cannery crop are grown by this method.

Seedbed-Cold Frame Method. By this combination the plants are transplanted twice; from the seedbed to the cold frames and then later to the field. The seed is broadcast thickly in the seed bed. In cool areas seed beds may be artificially heated. When the seedlings have from 2 to 4 true leaves they are transplanted into the cold frames. This method, though formerly the common one for producing plants for the canning crop, is now used most extensively in those areas where seed germinates poorly in cold frames.

Direct-Seeded Hot Bed Method. This method is very similar to the direct-seeded cold frame method except that artificial heat is provided and glass sash is generally used for cover. It is used for producing plants for early market plantings, particularly in the San Joaquin Valley.

Greenhouse Method. The seed is sown thickly in flats, either in rows or broadcast. When the seedlings have 1 or 2 true leaves they are transferred to other flats giving a spacing of 2 inches between plants in each direction. Sometimes the seed is started in flats in the greenhouse and the seedlings are transplanted to cold frames or hot beds. This method is used primarily by commercial plant growers for producing plants for certain of the early market plantings.

Open Plant Bed Method. This method is very similar to the direct seeded cold frame method except that no frames or covers are used. Black building paper may be used to cover the soil during the germination period to provide extra heat and reduce loss of moisture. This method is practical when the danger of frost is past and the normal temperatures after emergence will be suitable for the growth of tomato plants.

This method might be used in preference to the open field method. when field irrigation is impractical, soil temperatures in the field are too low for good germination, or the space allotted for growing the plants is limited.

Open Field Method. The seed is drilled in rows 15 to 18 inches apart on the flat or on raised beds with two rows per bed. The beds are usually spaced 30 to 36 inches from center to center. The seed may be sown just sparingly enough to give a uniform stand of about 15 to 18 plants per foot of row or if more seed is used, the plants should be thinned to this spacing. Since no covers are used, good stocky plants can be obtained when proper plant spacings are allowed.

This is the cheapest method of growing plants. It is applicable when frost is not a hazard and normal soil temperatures are suitable. This method is followed by commercial plant growers in Coachella and Imperial valleys of California, Moapa Valley of Nevada and in a few protected, frost-free spots along the coast, to produce plants for shipment to the canning and summer market districts. Most of the transplants for the fall market crop can be grown by this method, since seeding can be delayed till the frost hazard is past.

COMPARISON OF DIRECT-SEEDED AND COMBINATION PLANT BEDS

Good transplants can be grown by either system. Advantages of direct-seeded beds are:

1. Reduced hazard of spreading diseases because of less handling of the plants.
2. 2 to 4 weeks less tie required for plants to reach field planting size because plants are not retarded by the intermediate transplanting of the other method.
3. Lower cost of growing plants gecause of lower labor requirements.
4. The labor load is spread rather uniformly over the plant growing period.
5. Due to the shorter growing period, the beds often can be started later in the winter when temperatures are more favorable.

Advantages of the seedbed-cold frame combination are:

1. Conservation of plant space during the first part of the plant growing period.
2. Smaller area to seed, water and take care of during the germinating period.
3. Small hot beds can be used for germinating the seed when soil temperatures are too cool in cold frames.

PREPARATION FOR THE PLANT GROWING SEASON

LOCATION OF PLANT BEDS

Besides providing for full exposure to the sun, there are several factors that should be considered in regard to the choice of location for tomato plant and seed beds. These factors are as follows:

Clean Soil. Locate beds in an area that is known to be free from root-knot nematode, wireworms, Fusarium wilt and Verticillium wilt. DO NOT bring in sand or soil that might be infested with these diseases or pests, and beware of old tomato soil or old garden sites.

It is advisable to locate plants and seed beds in a new spot each year. But if absolutely clean plants have been produced in a bed the year before, and all plants remaining in the bed have been destroyed immediately after the planting season, it is sometimes advisable to use the same beds again, rather than gamble on a new site.

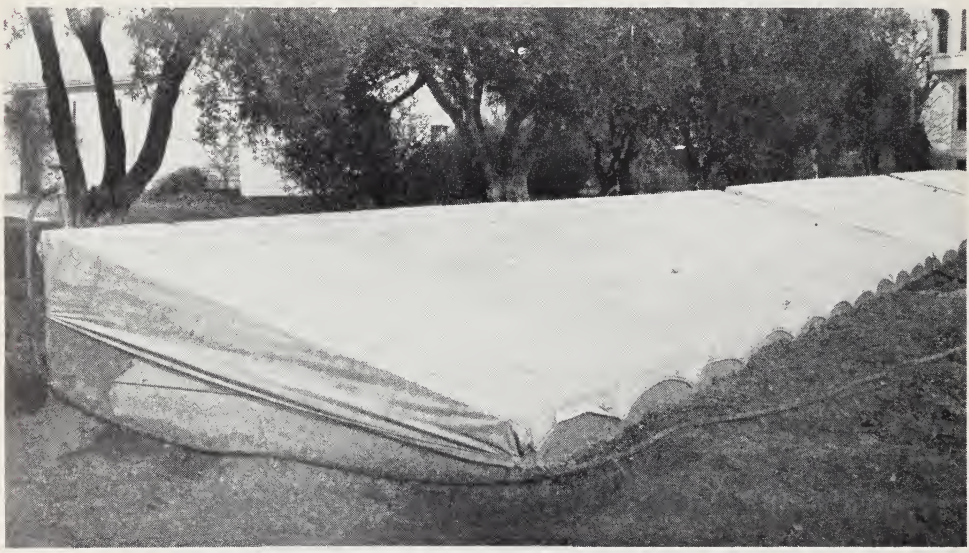
This is a matter for the individual grower to determine, based on what he believes to be the condition of the bed.

Good Drainage. Plant and seed bed soil should have good surface and subsoil drainage. The ground level inside the frame should be at least 6 inches above the soil level around the outside of the frame, to protect against seepage.

Light Soil. Sandy through to silt loam soil types are preferred, particularly for seed beds. Heavy clay soils, although sometimes used for plant beds, are difficult to work, become very hard when dried out and are slow to warm up.

Protection From Winds. If possible, locate beds where trees or natural topography will give protection from prevailing winds at the season of the year when the beds are in use.

Water Supply. An adequate water system is necessary for watering the seed and plant beds.



This is the type of frame generally used for hot beds and seed beds. Frame is from 5 to 10 feet wide and as long as convenient. The top usually slopes toward the south to take advantage of maximum sunlight. Note the method used for fastening muslin cover to keep it secure in wind.

CONSTRUCTION OF FRAMES AND COVERS

Seed Beds and ***Hot Beds*** usually are frame structures 5 to 10 feet wide, with their tops sloping toward the south for maximum sunlight, as illustrated on page 5. The north side is usually boarded up to a height of 2 to 3½ feet. Muslin or glass sash covers are used. It is sometimes advisable to provide extra cover that may be thrown over to help hold in the heat on cool nights.

The most commonly used methods of introducing heat to the soil in hot beds is as follows:

1. Electric heating cables, which are easy to install, and when thermostatically controlled, maintain a uniform and desirable soil temperature with a minimum of attention.

   If properly cared for, cables will last for many years. This, plus the fact that they are relatively easy to install makes electric heating of hot beds the most economical method, when considered over a period of years. The initial cost, however, is usually high. Cables are available in 60-foot lengths, for 110 volt circuit, and 120-foot lengths for 220 volt circuit. Up to 4 cables may be connected with one thermostat.

   When preparing the bed, the cable should be looped back and forth, with 8 to 10 inches between each loop. The cable is then covered with 3 to 4 inches of sand or light soil and the bed is ready for seeding. The control bulb of the thermostat should be placed at the level of the seed.

   A 120-foot cable is adequate for 90 to 100 square feet of hot bed space and will require from 3 to 10 kilowatts per day, depending on the temperature setting, the amount of insulation around the bed and the weather conditions.

2. Hot water pipes, laid 12 inches apart, from 4 to 6 inches under the soil is another way of providing soil heat. Pipes should be either ½- or ¾-inch in diameter. Warm water may be circulated through the pipes by means of a thermostatically controlled pump. This method can provide satisfactory heating of the soil, but it requires more maintenance than electric heat, is rather difficult to install and remove, and the initial cost is rather high. Hot water heating is most feasible when water from natural hot springs is available.

3. Heat may be provided by organic material. Strawy horse manure is the best material for such beds, but other barnyard manure or such material as cotton hulls, straw or shredded corn fodder may be used alone or mixed with manure.

   In building a bed for using organic heat, a pit, at least one foot deep should be dug. The organic matter is then added, wet down and packed. At least 8 inches of packed matter should be used, and then covered with 3 to 4 inches of sand or soil. From 4 to 7 days are required for the material to start heating. Although the intial cost of this method is low, the labor required to prepare the bed is considerable, and very little control can be exercised over the amount of heat generated.

Cold Frames are usually constructed with gable ends, that is with slopes on either side, as shown in photo on page 7. They are usually 10 to 12 feet wide and often 50 or more feet long. They are frequently laid out in a north-south direction, especially where strong north winds prevail.

The sides are made of 1-inch lumber, with either $1 \times 4''$ or $2 \times 2''$ posts driven

inside the bed for support. The tops of all posts are cut off level with the tops of the side boards.

The ridge pole (usually a $1 \times 4''$) raised to about 3 feet above the level of the soil, should be rounded on the upper edge to prevent chafing of the cloth covers. Supporting posts (either $1 \times 4''$ or $2 \times 2''$) may be placed along the center line at 10-foot intervals to keep the ridge pole from sagging. Rafters (either $1 \times 2''$ or $2 \times 2''$) should also be spaced at approximately 10-foot intervals.

Frames may be used for several years, if the boards have been cleaned of all soil, and have been thoroughly dried, to prevent the carry-over of any diseases, plant pests, and the like.

In California, a good grade of unbleached muslin is commonly used for covering material. Any covering material should be light in color, to allow penetration of as much sunlight as possible. Dark covering, or canvas may be used if the beds are uncovered during the day.

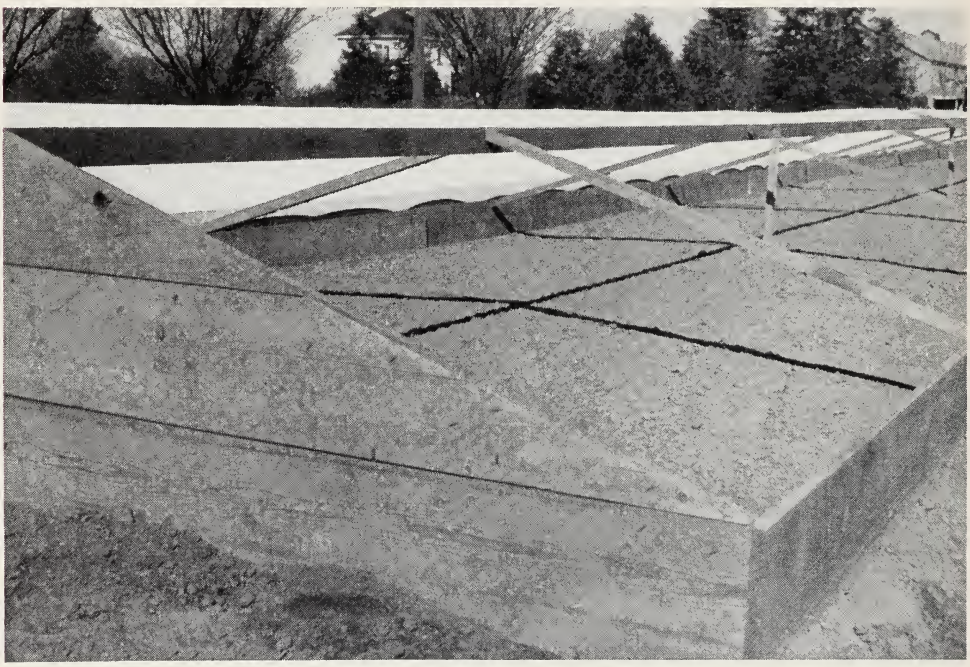
In sewing the cover material, it is well to have the seams running over the ridge, rather than lengthwise of the bed.

Strong, wide hems should be stitched around all covers.

The cover may be fastened to the frames with canvas loops, grommets (reinforced holes) or by sewing a rope into the hem which can be hooked over the heads of nails driven into the side boards.

SOURCE AND AMOUNT OF SEED

Source. Good seed is the first requirement for obtaining high yields and quality tomatoes. Seed costs represent such a small fraction of the total investment in a crop that there is little object in skimping on this item. Bacterial canker, Fusarium wilt and some leaf spot diseases are



This is typical of construction used for cold frames. Note gabled top with rafters spaced to support cloth cover. Note also how ground around the bed has been cleared of weeds that might act as host for diseases and pests on tomato plants. Beds usually should run north and south.

often seed-borne. Tomato seed should be obtained:

1. From a reliable dealer or producer.
2. From fields known to be entirely free from seed-borne diseases and from varietal mixtures.

Amount. One pound contains 150,000 to 200,000 seeds which normally give 25,000 to 30,000 good tomato plants. For canning tomatoes one pound of seed will provide plants for 10 to 15 acres, depending on the spacing. On closely spaced, staked tomatoes, a pound may plant only 3 to 4 acres.

Varieties. At present, Pearson is the principal variety grown for canning, with San Marzano, Early Santa Clara, and Stone of minor importance. Earliana strains, Pearson, Stone, Pritchard, 133-8, Firesteel, Pennheart, Stokesdale, and Rutgers are used for the market crop.

Processed (Coated) Seed. Coated, or pelleted tomato seed has been processed by adding a coat of clay or other inert material to the individual seeds. The purpose is to make a round, even-sized pellet that will permit more accurate spacing than can be obtained with regular seed. However, tests have shown that germination of the seed is greatly reduced when the seed is first treated for the control of seed-borne diseases and then coated. Even without treatment the germination of coated seed is usually slower and poorer than that of uncoated seed.

Since no definite advantages have been obtained by using coated seed in beds, the disadvantages mentioned above are sufficient to discourage its use.

SEEDING DATES

The seeding date will depend on the time the plants are desired for field planting and the conditions under which the plants will be grown. Good plants can be produced in 6 to 8 weeks under the most favorable conditions whereas 16 to 18 weeks may be needed in poorly heated beds in cold weather.

The usual period required to grow plants for the cannery crop is 10 to 12 weeks by the direct seeded cold frame method and 12 to 16 weeks by the seedbed-cold frame method. With the combination beds the seed should be planted about mid-January and with direct-seeded cold frames, seeding should begin about February 1 and be finished by March 1. A month spread in seeding period at this time of year will mean about two weeks spread in the time plants reach transplanting size.

November to January is the usual seeding period to produce plants for the spring market crop. Beds used to produce plants for the fall market crop are usually started in late March and April so the plants will be ready for transplanting during June or early July.

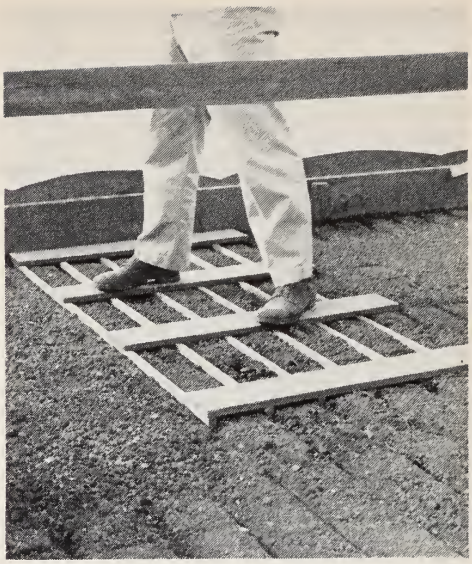
CULTURAL MANAGEMENT OF PLANT BEDS

SOIL PREPARATION

The soil should be finely worked to a depth of 4 to 5 inches. For small plant bed areas spading may be the most practical but for larger areas power farm tools are used. Small garden type rototillers also have proven very satisfactory for soil preparation of plant beds. It is advisable to prepare the soil during a favorable weather period in advance of the seeding period and then cover the beds to shed heavy rains. Also at this time eradicate all weeds and other vegetation from the vicinity of the seed beds. Just before seeding, the clods should be pulverized and the soil should be raked, carefully leveled, and firmed. If the soil is too dry for good germination, it should be moistened two or three days before planting. This is an important point.

FERTILIZING

Most soils are fertile enough for growing transplants. If too much fertilizer is added, growth may be rather lush, making it difficult to harden the plants. In some cases, especially on very sandy soils, yellowing and stunting of young plants may be due to a deficiency of nitrogen. This can be corrected by dissolving one pound of fertilizer, such as nitrate of soda or ammonium sulfate, in four gallons of water and applying this amount to 500 square feet of plant bed. The fertilizer solution should be washed off the foliage with fresh water to avoid burning the leaves. On very sandy soils where plants may have grown poorly in past years, well rotted manure might be worked in during preparation of the seed bed.

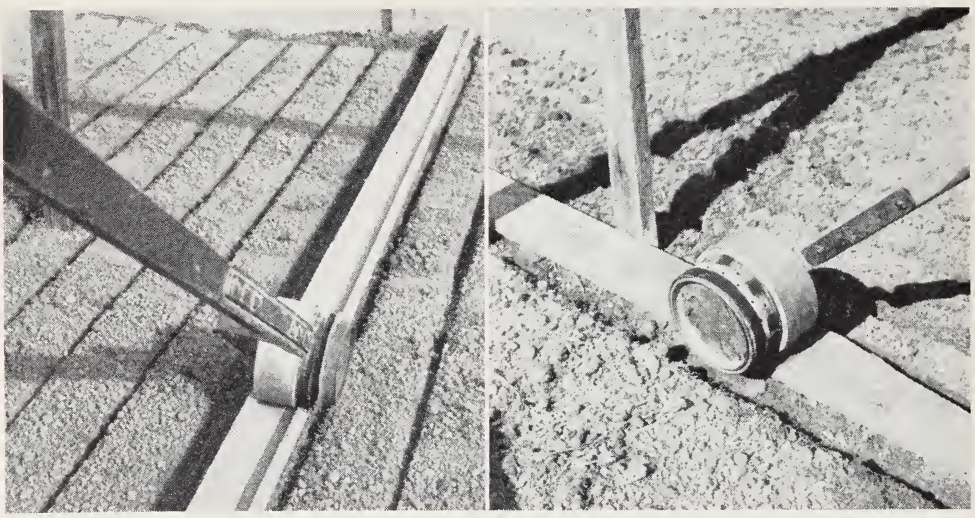


This is a popular method for making furrows for seeding in a seed bed. This instrument is inexpensive to make and very simple to operate.

SEEDING

With direct seeded beds it is desirable to seed in rows to permit easier weeding and thinning. A wide plank with cleats on the bottom can be used to make furrows. The seed may be sown by hand, with small seeders, or with commercial hand drills. (See photo.) A good seeding rate is 25 to 30 seeds per foot in rows 6 inches apart. Some growers prefer row spacings of 4 to 5 inches while others like 8 inches between rows. The seed should be covered with ½ to 1 inch of soil. One pound of seed is sufficient for about 5 beds 10 × 50 feet.

For seed beds the seed is usually broad-



Types of hand seeders in common use. The cleat in picture at left acts as a track for guiding the seeder; photo at right shows seeder being used on flat board. Directions for making this seeder may be obtained free on request from Division of Truck Crops, University of California, Davis.

cast by hand using about ½ pound of seed for a bed 10 × 20 feet. The seed is covered with ¼ to ½ inch of soil. A mulch of paper, burlap or peat moss will aid in holding moisture around the seed, but in cold frames may tend to reduce heat absorption in the soil. A mulch should be removed as soon as the plants emerge.

In seeding open field plant beds, Planet Jr. or similar drills are commonly used. They are adjusted to drop 35 to 45 seeds per foot of row. The seed is covered with ½ to one inch of soil. About 6 to 7 pounds of seed are used per acre.

Uniform depth of covering and good contact between soil and seed are important in obtaining good germination. These requirements can be met by providing a fairly firm seed bed and by firming the soil over the seed. Watering after seeding will aid in firming the soil.

Seed beds are sometimes covered with ½ inch of white sand which helps reduce crusting, but sand may keep the beds cooler by reflecting much of the heat. The sand also dries out faster than other soils.

This is the type of hoe sometimes used for covering seed in rows. It can be made from an ordinary type of hoe easily and inexpensively.

TEMPERATURE CONTROL

The most favorable soil temperatures for germinating tomato seed are 65° to 75° F. In moist soil at a constant temperature of 75° F the seedlings will emerge in 5 to 10 days and at 65° F seedlings will emerge in 10 to 14 days, with nearly perfect germination. At 55° F from 3 to 4 weeks are required for seedlings to emerge, and germination usually drops to about 75 per cent. A hot bed thermometer is useful in checking soil temperatures.

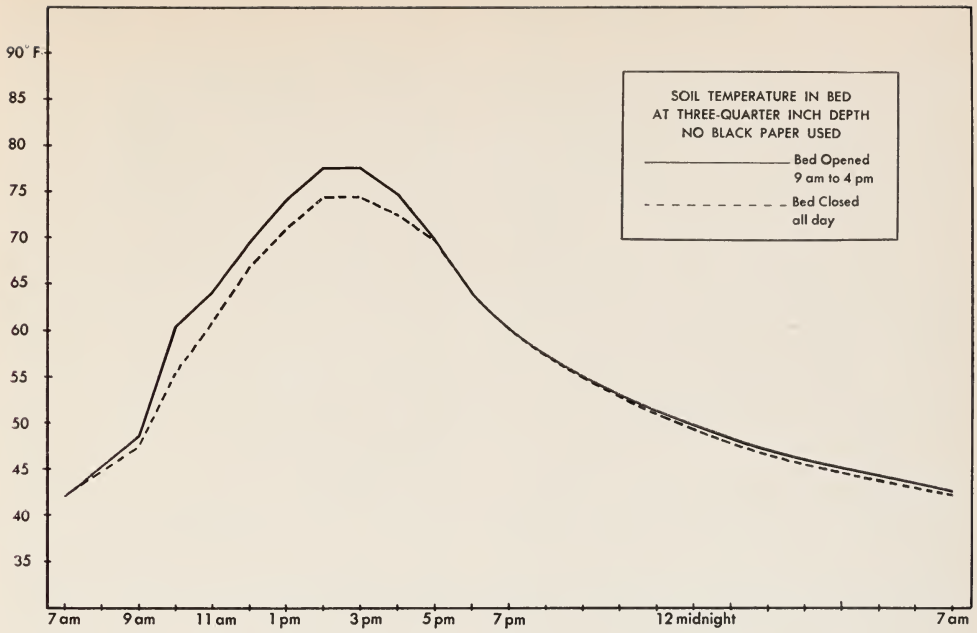
Soil temperatures in muslin-covered cold frames can often be improved during the germination period by removing the covers during sunny days. The soil will warm faster during the morning with the covers removed, and may reach a midday temperature 5 to 7° F higher than the soil in closed beds. Care should be taken to prevent drying out the soil, when covers are removed.

Covering the soil with black building paper will give still greater heating of the soil if the muslin covers are removed during the day. However, black paper with the covers on may keep the soil cooler than it will be without the paper. (See charts, pages 11–12.)

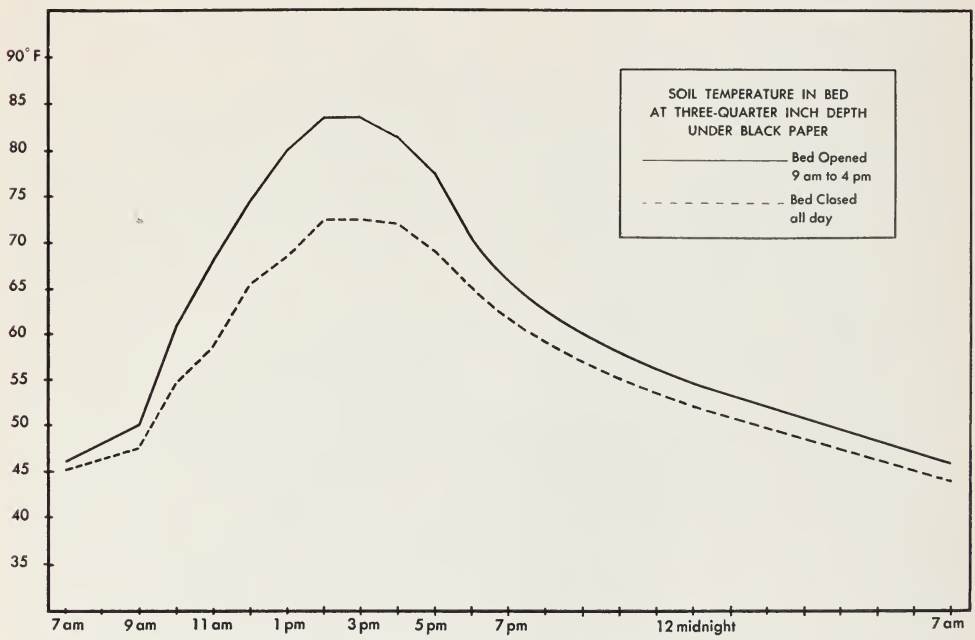
If paper is used, it should be removed at the first sign of plant emergence.

During clear nights, the loss of heat through muslin or glass-covered beds is rather high, and the soil down to 1 inch below the surface may cool almost to the air temperature. The use of fiber mats over glass covers will help to reduce the loss of heat during the night. Extra covers for muslin-covered beds will also prove helpful in reducing heat loss.

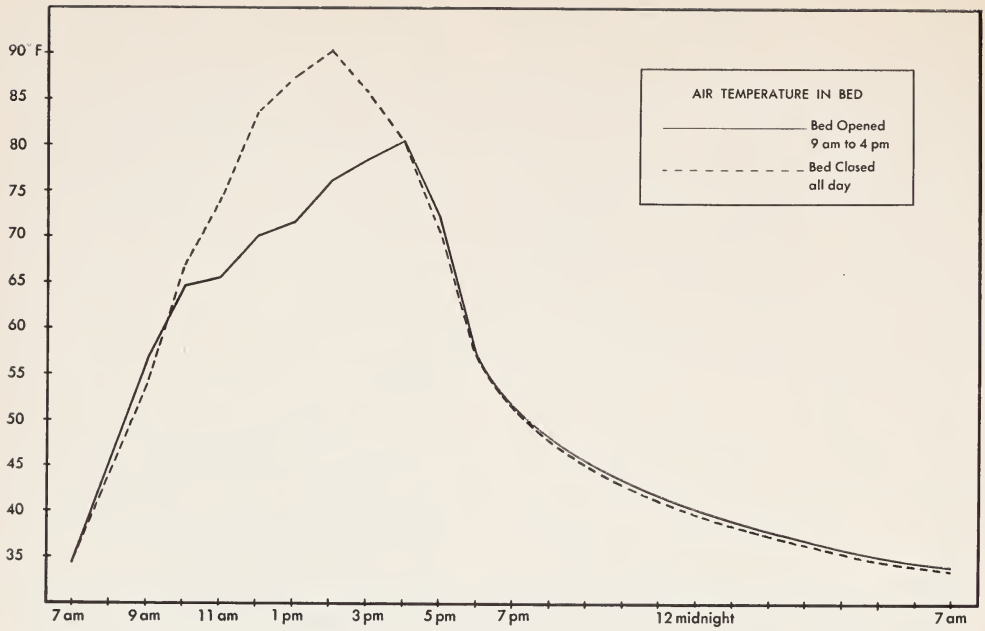
After Germination the best plants will be produced if the air temperatures within the beds range from 65 to 75° F. Temperatures over 75° F will promote more rapid growth, but will tend to make the plants spindly, and more difficult to harden off. Temperatures should be regulated throughout the day, and according



This chart illustrates the point made on page 10 regarding soil temperatures in beds covered with muslin. These records were made on a clear day in February. This chart shows the advantage of opening the beds during the day to warm the soil.



When black paper is used, it is necessary to open the beds during the day to obtain maximum benefit from the sun's heat, as shown by this chart. Any benefit from using black paper is lost when the muslin cover is left on—the soil may even remain colder.



In contrast to soil temperatures, the air temperatures on a clear day will run higher under a muslin cover, as shown in this chart. However, heating of the air becomes important only after the plants have emerged, and should be watched carefully then.

to the weather, by removal and replacement of the covers.

WATERING

The soil around the seed must be kept moist until the plants emerge. Allowing the soil to become dry slows germination. On the other hand, overwatering may tend to keep the soil cooler. Frequent inspection of the beds is necessary and as soon as the moisture is lost at the seed level, it should be replenished with a light watering. Sprinklers or "water wands" may be used as hose attachments. (See photo, page 13.)

After the plants have emerged the soil can be allowed to dry somewhat deeper so less frequent but heavier waterings are advisable. Just enough water should be applied to keep the plants growing well until they approach transplanting size. At this stage the plants should be hardened by allowing the soil to become fairly dry. Often 2 or 3 good waterings after the plants emerge will suffice on most soils. Water during midmorning on sunny days so the soil surface will dry quickly. Keeping the surface soil dry as much of the time as possible will help reduce losses from damping-off.

VENTILATION

During the Germination Period, ventilation is relatively unimportant. With muslin covers, opening the beds on sunny days will warm the soil faster, but it will also dry out the soil, so more frequent watering may be needed.

After Emergence, opening the covers to ventilate the plants not only helps to reduce humidity within the beds, but tends to dry off the soil, which is part of the necessary process for hardening off the plants. Thus removing the covers during the day, any time after the plants have one or two true leaves, will encourage development of sturdy plants.

Starting about two weeks before the plants will be ready for transplanting, the covers should be left off all night, unless there is danger of frost.

WEEDING

Pre-emergence weeding of plant beds with flame-guns often will materially reduce the amount of weeding necessary later on. Many weed seedlings that hardly are visible can often be eradicated. Flaming is safe if done 1 to 2 days before the first tomato seedlings will emerge. The proper time has to be determined by carefully examining a few seeds at frequent intervals.

After the plants emerge, weeding in the row is done by hand while narrow bladed hoes can be used in the middles. A hoe made of a piece of strap iron bent into a V-shape and attached to a handle has proved very satisfactory. Beds in which the seeds are broadcast require all hand weeding. Weeding should be done while the weeds are small to avoid competition and disturbance to the tomato plants. (See photo, page 14.)

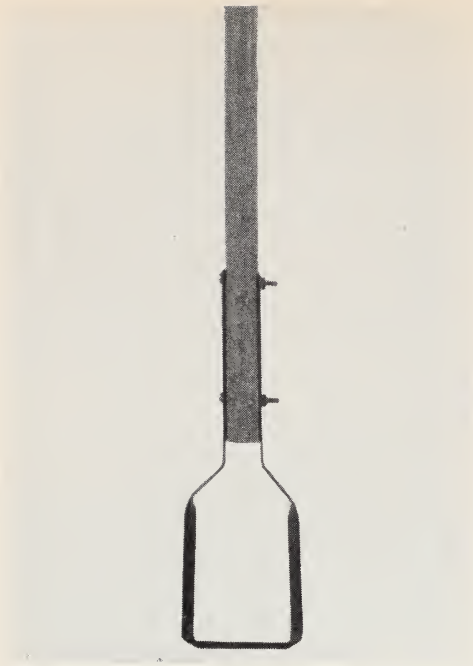
FROST PROTECTION

Since heat radiates more quickly through muslin and glass covers, these covers seldom afford sufficient protection against heavy frost. On nights when heavy frosts are expected, one or more of the following procedures may be adopted:

1. Use extra covers over the beds.
2. Furnish heat inside the bed with the use of hot air heaters, electric lights or electric heating cables.
3. Heat the air around the beds with smudge pots.

The use of oil heaters in closed beds is dangerous because of the fumes given off. If oil heaters are used, they must be carefully vented to remove all fumes, and some ventilation should be provided. Protection should also be taken against the hazard of fire.

Sprinkling a direct-seeded bed during the germination period. The soil around the seed must be kept moist until the plants emerge. At each sprinkling, apply enough water to wet the soil down below the seed. Any of a number of sprinkling or watering devices may be used.



Workmanlike weeding hoe that can be made from strap iron bent into a V-shape and fastened to a stout handle of any length that is handy.

PLANT SPACING AND THINNING OF DIRECT SEEDED BEDS

In most direct seeded beds some thinning of the young plants is required. A spacing that provides about 6 square inches per plant is economical and gives good plants. This means one plant per inch in rows 6 inches apart. Closer spacings tend to give tall, spindly plants. Although wider spacings usually result in stockier plants, the cost of growing goes up because of fewer plants per bed.

Thinning should be done when the plants have 1 or 2 true leaves. Leave the best plants and do not handle them while thinning. Weeding in the row can be done while thinning, but weeds between the rows should be removed with hoes before thinning.

TRANSPLANTING FROM SEED BED TO PLANT BED

Transplanting should be done when the plants have 2 to 3 true leaves. Soak the seed bed well before pulling the plants. Discard all plants that are weak, injured or show evidence of diseases. Handle plants carefully to avoid bruising the stems.

In the plant bed a desirable spacing is 8 to 12 square inches per plant. Space plants 2 to 3 inches apart in rows 4 inches apart. A notched board may be used as a planting guide. The plants should be set about one inch deeper than they were in the seed bed. Cover the roots with a little soil, water in the trench and then bring relatively dry soil up around the stem.

The three steps in first transplanting: After a thorough soaking, pull the plants and cull out weaker ones, taking care to disturb roots as little as possible. Replant in rows, firming some soil around the roots. Notched board is used to space plants evenly. Apply water in the furrow so only

Wet surface soil at this time induces damping-off. Do not water again for several days. Except to dry off the soil surface after a rain or a sprinkling, keep the covers on until the plants have started growing again. After that, open the beds frequently during the day, when the weather is favorable.

When greenhouse flats are used for growing the plants, 2 by 2 inch spacing is commonly used.

From 10 days to 2 weeks are required for the plants to re-establish their root systems and begin growing again.

HARDENING

In hardening, growth of the plants is slowed so that food will accumulate in the stems, roots, and leaves. This storage of food toughens the plant, making it easier to handle in transplanting as well as better able to stand the shock of transplanting and to survive in the field. The stored food helps the plant to quickly establish the new root system. Thus properly hardened plants usually start growing sooner than soft succulent plants. The hardening process should not be overdone, however, since plants that have been stunted too much or too long may be slow to return to active growth.

This is a popular type of flame weeder that is commonly used for pre-emergence weeding in seed beds or in direct-seeded plant beds.

Hardening is accomplished by withholding moisture, and by exposing the plants to full sunlight and cool night temperatures. Full sunlight should be provided during as much of the plant growing season as possible. The plants should

roots get wet. Soil firmed up around stems should be fairly dry. Note that muslin cover is rolled back as workers progress to shield newly transplanted tomatoes from the direct sunlight. After transplanting, withhold water to prevent damping-off.

be exposed to night temperatures and a shortage of moisture for at least 10 days before transplanting into the field. On most soils it is necessary to water sparingly for some time in advance in order to bring the soil moisture content under control at the desired time. An irrigation late in the hardening period will start new growth in 2 or 3 days which will nullify all previous hardening. If topping becomes absolutely necessary because of excessive growth of the plants, do it about a week in advance of the time the plants will be used.

DISEASE CONTROL IN PLANT BEDS

The prevention or control of tomato plant bed diseases is of primary importance in the production of tomatoes. Most of the diseases originating in the plant bed and in many cases introduced into the field from the plant bed can be adequately controlled by careful attention to plant bed management. Some of the diseases are introduced into the plant bed with the seed, some are soil-borne and others are introduced by insects or by mechanical means. Below is given a brief description of the common diseases occurring in the plant beds and the necessary measures that should be practiced to insure the production of the maximum number of healthy plants for field planting.

DAMPING-OFF

This is primarily a disease of the seed bed and plant bed and is caused by several types of soil-inhabiting fungi. These fungi often attack and kill the germinating seed before the seedlings reach the soil surface, resulting in a condition commonly known as pre-emergence damping-off. Later these organisms attack the young stem at the soil surface causing the plants to wilt and fall over. The disease spreads rapidly under high humidity conditions and may completely destroy a seed bed or plant bed in a few days if control measures are not taken.

BACTERIAL CANKER

This is a destructive seed-borne disease of tomatoes. The disease frequently shows to the practiced eye in the plant bed just before the plants are ready for field transplanting. Infected plants are dwarfed and show a sudden wilting of the leaflets, usually on one side of the plant. The wilted leaflets turn brown and die but the petioles remain attached to the stem. The internal stem tissue soon becomes soft and light yellow in color. Bacterial canker is readily spread from diseased to healthy plants by topping knives and handling of the plants. Good seed, seed treatment and avoiding the topping of plants are the best control practices for this disease.

SEED TREATMENT FOR SEED-BORNE DISEASES AND PRE-EMERGENCE DAMPING-OFF

As a matter of safety, all seed should be treated before planting—irrespective of source.

Either of the two seed treatments described below will tend to protect resulting plants from both bacterial canker and pre-emergence damping-off. There is little choice between the treatments except that of convenience of the grower.

New Improved Ceresan Treatment. The New Improved Ceresan seed treatment is effective for both surface and seed-borne diseases and pre-emergence damping-off. In addition to killing seed-borne fungi and bacteria, it leaves a residue of the chemical on the seed which gives considerable protection against damping-off fungi in the soil.

Seed should be soaked for *exactly 5 minutes* in a 1 to 1200 solution made by dissolving *1 level teaspoon* of New Im-

proved Ceresan in 5 quarts of water. Use 1 gallon of solution for each pound of seed. Use an earthenware crock or wooden tub, never a metal container. Use a fresh solution for each lot of seed treated.

Seed should be enclosed in a loosely woven cloth bag (usually about one-third full) and immersed in the solution. The bag should be constantly agitated while in the solution to insure quick and thorough wetting. When removed from the treating solution, the *seed* is *not* rinsed but should simply be squeezed to remove excess solution and then spread out to dry as quickly as possible. Seed may be treated in advance of seeding time but should be kept dry and not stored in tight containers. Dusting with yellow copper oxide is not necessary after this treatment.

Mercuric Chloride Plus Yellow Copper Oxide Dust Treatment. An alternate seed treatment that may be used is the mercuric chloride dip plus copper oxide dusting. Either the prepared tablet form or the white powdered mercuric chloride may be used. Dissolve 4 large or 16 small tablets or 1.9 grams of the white powdered mercuric chloride in 1 gallon of water. This will give a 1-2000 solution. Mix thoroughly in a wooden or earthenware container. Use 1 gallon of solution for each pound of seed, *never more or less. Use solution only once.* Put the seed in a loosely woven cloth bag (usually about one-third full) and immerse in the mercuric chloride solution. The bag should be constantly agitated while in the solution to insure quick and thorough wetting. Leave the seed in the solution exactly 5 minutes, remove bag and rinse the seed immediately in running water for 15 minutes. This may be conveniently done by tying the open end of the bag around a water spigot and allowing the water to run over the seed with sufficient force to thoroughly wash the seed. After washing, squeeze the excess water from the seed and spread out in a thin layer and dry as quickly as possible. (*Mercuric chloride is a deadly poison and should be handled with care. Used mercuric chloride solution should be disposed of in a way that will prevent its being a hazard to livestock. Do not pour it on the ground. Keep it away from children.)*

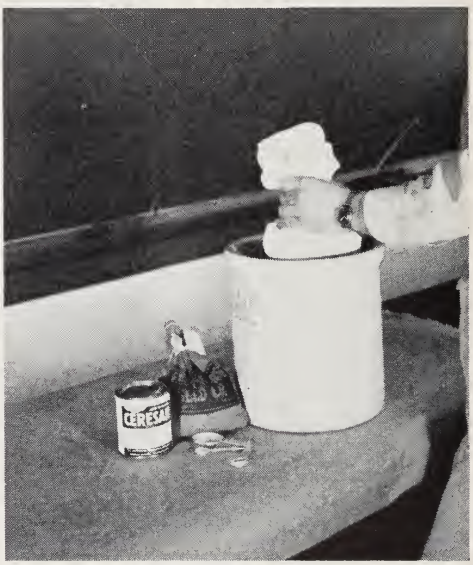
After the seed has been thoroughly dried, it should be dusted with yellow copper oxide for protection against preemergence damping-off. Use *1 level teaspoon* of dust for each pound of seed. Place seed and dust in a tight container and shake vigorously for several minutes to insure an even coating of dust on the seed.

The disadvantage of this method of treatment is the necessity of thoroughly washing the seed after immersion in the mercuric chloride solution, and a second treatment for damping-off control after drying.

Seed may be treated well in advance of planting time if kept stored in a dry place.

SEMESAN SPRAYS FOR POST-EMERGENCE DAMPING-OFF

As soon as the plants emerge from the soil, they should be sprayed with a normal Semesan solution. The treatment



Materials needed for seed treatment against seed-borne diseases. Wooden bucket may be substituted for crock. NEVER USE METAL.

should be repeated at 7- to 10-day intervals, until the plants are thinned or are ready to transplant to cold frames.

A normal Semesan solution is made by mixing *1 level tablespoon of Semesan* in 1 gallon of water. Apply at the rate of 3 to 4 gallons per 100 square feet of bed.

When the young seedlings are transplanted from the seed bed to the plant bed, water should be applied to the roots only and dry soil firmed around the stems. Keep the surface soil dry until the plants have become established. It is also advisable to spray the plant bed thoroughly with a Semesan spray as soon after transplanting as possible. After the young plants become established and straighten up, damping-off can usually be controlled by careful watering and ventilation. Watering should be done early in the day and the beds left open to permit the plants to dry off before covering.

MOSAIC

Mosaic caused by the tobacco mosaic virus is one of the most prevalent of the virus diseases and is characterized by a light and dark green mottling of the leaves accompanied by some curling and malformation of the leaflets. Early infected plants are usually dwarfed and, under restricted light conditions such as prevail in hot beds and cold frames, often show considerable temporary leaflet malformation somewhat resembling the shoestring type of mosaic. As the name implies, the same virus affects tobacco and may be present in an active form in the various forms of commercial tobacco. Since this disease is transmitted readily from diseased to healthy plants by handling, it is advisable to inspect the plant beds carefully when the plants are about 6 inches high and remove all plants showing mosaic or mosaiclike symptoms. This will prevent the workers contaminating their hands when handling plants.

The *use of tobacco* in any form by plant bed workers is a *dangerous practice.* The disease can be carried on the workers' hands to the young tomato plants. Once the disease has been introduced into the plant bed, it is easily spread to other plants by insect vectors and by the necessary handling of the plants in the transplanting procedure. Periodic washing of the hands with laundry soap and water during the transplanting operations is advisable. Mosaic also affects a large number of weeds as well as some garden plants. It may be spread from these hosts to tomato plant beds by insects. Clean cultivation should be practiced in the vicinity of the plant beds.

OTHER PLANT BED DISEASES

Shoestring Mosaic caused by the cucurbit mosaic virus also attacks tomatoes and is much more serious than the tobacco virus. It is characterized by the curled and distorted leaflets and the shoestring or fern leaf type of malformation of the leaves. Under restricted light conditions existing in plant beds, ordinary mosaic is often confused with shoestring mosaic. However, the malformation of the leaves is usually much more pronounced in the latter and the plants never recover. It is transmitted by aphids from perennial weed hosts and from cucurbits (cucumbers, squash, gourds, etc.) growing in the vicinity of the seed beds and plant beds. Clean cultivation should be practiced around the beds to destroy possible sources of the cucurbit virus. As soon as aphids are observed a nicotine or pyrethrum dust should be applied. Nicotine dust or black leaf 40 does not carry mosaic.

Spotted Wilt (die back or tip blight) is a virus disease transmitted by thrips and causes tremendous damage in the coastal districts. Occasional infestations have been observed in the interior valleys. The disease is characterized by the appearance of numerous circular dead spots on the young leaflets, by a bronzing of the upper surfaces of these leaflets, dead spots on the petioles and stem and blighting of the tips. The disease also attacks many

ornamentals, vegetable crops, and weeds which serve as reservoirs of infection for tomato plant beds. Ornamental plants and weeds should be eradicated from the vicinity of plant beds. For greenhouse tomatoes frequent fumigation is necessary.

Curly Top or western yellow blight is caused by the sugar beet curly top virus and is transmitted by the beet leafhopper. This disease does not usually show in the plant bed.

Leaf Spot Diseases. During excessively wet periods when it is impossible to open the plant beds for ventilation, *early blight* or Alternaria leaf spot and *bacterial speck* may attack the plants and do considerable damage to the foliage and stems. Early blight is characterized by dark brown, irregularly circular spots on the leaves, each of which, when closely examined, shows concentric lines. This fungus often causes black cankers on the stem, producing a serious field disease known as *collar rot.* Bacterial speck is evident by numerous very small, round, dark brown to black, somewhat greasy specks on the leaves.

If the beds have been sprayed as recommended under damping-off control with Semesan solution, the leaf spot diseases will probably be held under control. Plants showing leaf and stem infection of early blight should not be used.

GENERAL CONTROL MEASURES

Do Not Top Plants. The practice of topping the plants before transplanting to the field is dangerous. Bacterial canker and mosaic may be spread to the majority of the plants by this procedure. Handle the ventilation and watering so that the production of tall, succulent plants that require topping is avoided.

Rogue Plant Beds. Plant beds should be examined carefully before transplanting the plants to the field. All small and stunted plants as well as plants showing mosaic mottling should be carefully removed and destroyed. Stunted plants showing wilted leaves are evidence of bacterial canker and should be carefully examined for internal browning and tissue breakdown. Plant beds showing *bacterial canker* and heavy infection of *early blight, shoestring mosaic* and *spotted wilt* should be discarded.

CONTROL OF INSECTS IN PLANT BEDS

Insects and other pests are sometimes troublesome in tomato plant beds, and growers should be prepared to combat them if serious outbreaks occur and prevent their being carried into the field from the plant beds.

Tomato Russet Mites overwinter on old tomato plants, petunias, and nightshade. Eradicate these and any volunteer tomato plants from the vicinity of plant beds, and from borders of fields where tomatoes will be planted. If mites are suspected, plants may be dusted with sulphur before they are taken to the field.

Chewing Insects that cut off the stems, such as *darkling ground beetles* and *cutworms* can be controlled by dusting the base of plants thoroughly with cryolite or calcium arsenate or by the use of poison bran bait. A 5% DDT dust also can be used if the application is very light. A too heavy application or repeated light applications of DDT on young tomato plants may result in injury.

Springtails are very small insects that chew off the cotyledons (first leaves) of young seedlings. Nicotine or pyrethrum sprays will control these pests. DDT dust, when used for the control of other pests, will usually provide adequate control of springtails.

Flea Beetles are small jumping insects that eat small holes in the leaves and can be controlled by light but thorough dusting of the plants with cryolite or calcium arsenate. A 5% DDT dust can also

be used, but should be very lightly though thoroughly applied.

Tomato Pinworms can be controlled by dusting with cryolite just before transplanting in the field. Here again a 5% DDT dust can be used but the application should be extremely light.

Aphids or ***Thrips,*** if necessary, can be controlled by thoroughly dusting the bed with a number 10 nicotine dust, or a dust containing parathion, or organic phosphate.

Wireworms occasionally cause damage in plant beds by feeding on the seed and later on the roots and stems of the young plants. No control measures are possible after the beds have been seeded. If it is impossible to select a site that is free of wireworms, the soil can be fumigated with ethylene dibromide (EDB) at least 3 weeks prior to seeding.

Another possible control measure for wireworms is to spray the beds with lindane (gamma isomer benzene hexachloride) and work the material into the soil before seeding. A suggested dosage is 0.4 to 0.8 oz. of 25 per cent wettable lindane in 2½ gallons of water for 1000 square feet of plant bed. Never use more than 0.8 oz. of lindane. Two heaping tablespoons of lindane is roughly equivalent to 0.4 oz.

Seed Corn Maggot is a white maggot that drills in the stem causing wilting and then death of the young plants. The adult flies lay the eggs in the soil, and these hatch in 3 to 4 days. The infestation usually lasts 7 to 10 days and then the maggots disappear. Seldom are all of the plants in a bed destroyed. Since it is impossible to predict outbreaks of this pest and the infestation is of short duration, it is difficult to secure adequate control. Dusting lightly with 5 per cent chlordane may give some relief if applied at the first sign of infestation.

Slugs and ***Snails*** can be controlled easily by spreading prepared poison bran bait that contains both calcium arsenate and metaldehyde thinly around and in the beds. Usually with clean cultivation these pests will not be troublesome.

Nematodes can be recognized by the small galls they cause on the roots. Plants infested with nematode in the plant bed often are stunted and when transplanted in the field will seldom produce a good crop. Furthermore, such plants will introduce the pest into clean fields.

Never use the plants from beds in which nematode has been found, unless perhaps the plant bed infestation is slight and they will be planted only in fields where the pest is already present.

The selection of a plant bed site entirely free of nematodes is the only reliable safeguard. When clean sites are not available fumigation of the soil with dichloropropene mixtures (sold as Shell D-D and Dowfume N) will usually reduce the nematode population, but cannot be relied on to completely eradicate the pest. The treatment should be applied at least 3 weeks prior to seeding and when the soil is 55° F or warmer. In plant beds the dichloropropene mixtures should be applied at the rate of 40 gallons per acre.

CONSIDERATIONS AT TRANSPLANTING TIME

Transplanting of the cannery crop normally is done between April 20 and May 20. Plantings for market are made from the first of February until late July, depending on the district and the time harvest is desired.

The object during transplanting is to insure the survival and rapid recovery of each plant set in the field. Obtaining a satisfactory stand from the first transplanting is important. Replanting, though sometimes necessary, is costly and replants, because of later setting, are generally low yielders.

Survival and rapid recovery of transplants is dependent on:

1. The selection of good plants.
2. Avoiding unfavorable weather conditions during transplanting.
3. Careful removal of plants from the plant beds.
4. Firming the soil well around the roots as the plants are set out.
5. Provision of good soil moisture conditions.
6. Protection of the plants from insect pests immediately following transplanting.

TYPE OF PLANT

A desirable tomato transplant is 8 to 12 inches tall with a straight stem the size of a pencil, has several leaves, shows a reasonable number of roots, and is free of diseases and pests. Proper hardening is indicated by dark green foliage and a tough stem showing some purple color and small bumps on the lower portion of the stem. The size of the root system is not too important since new roots must be developed before growth can be resumed.

Weak, leggy, stunted, or diseased plants should be culled out while pulling or transplanting. (See photo.)

DIGGING PLANTS FROM THE BEDS

The plants should be removed from the beds as they are needed in the field. Although well protected plants may survive several days storage, best results are obtained when plants are set out immedi-

The two plants on the left are spindly and undesirable for transplanting. The three on the right are healthy, well-formed plants and should produce good yields. Plants showing evidence of disease, as described on pp. 16, 17, 18, and 19, should not be used. Photo courtesy J. H. MacGillivray.

ately after digging. The beds should be soaked in advance of pulling. Pull the plants individually to avoid breakage and to separate each plant. Loosening the soil with a spade may help on heavy soils. Pack the plants upright in boxes lined with wet newspapers or sacks and protect the plants from the sun and winds. Mudding the roots appears to have little value.

With open field beds, the plants may be pulled dry after running a cutting blade or lifter under the beds or plant rows, or the portion of the field to be harvested can be irrigated to soften the soil for the pulling. Only the beds to be transplanted at the time should be watered, because plants that are irrigated and then left for a few days will resume growth and become succulent.

When plants are to be shipped, they are sorted, bunched in groups of 50 and then packed in lettuce crates or similar containers. Wet moss or paper is packed around the roots.

HOLDING PLANTS

When it becomes absolutely necessary to hold plants for a few days after pulling they should be stored at a temperature of about 50° F. When plants are held in crates, full shade is preferable to sunlight or complete darkness, and adequate circulation of air around the crates is necessary to prevent self-heating.

When feasible, it is better to unpack the plants and "heel" them in the ground, either individually or in bunches.

The roots should be kept wet during the holding period.

TRANSPLANTING INTO THE FIELD

Planting. The soil should be well pulverized and mellow to the depth the plants will be set. Transplanting is done with machines or by hand. Cross marks are often used to designate the spacing in the row. Set the plants upright and 3 to 4 inches deeper than they were in the plant bed. It is highly important that the soil be firmed well around the roots to eliminate all large air spaces. To do this the packers on the transplanter must be carefully adjusted.

Spacing. For the canning crop, row spacings of 5 to 6 feet are most common. Pearson plants are set from 1½ to 4 feet apart in the row. Larger growing plants are set from 3 to 6 feet apart.

Recent spacing tests indicate that the close plant spacings of 1½ to 2 feet apart in the row give higher early yields and frequently greater total yields than do wider spacings. A $6' \times 2'$ spacing requires 3,630 plants per acre. For market crops row spacings range from 3½ to 7 feet; plant spacings from 1 to 6 feet. For staked tomatoes spaced $4' \times 1'$, 10,890 plants are required per acre.

Watering. When transplanting machines are used, and sometimes in hand planting, one to two pints of water is supplied to each plant. This water settles the soil around the roots and provides readily available moisture. Additional moisture may not be needed for some time in soils that are moist to the surface at transplanting. However, if most of the moisture in the upper 6 inches of soil has been lost in preparing the land, an irrigation should follow soon after planting. The furrows should be close to the rows of plants for this irrigation.

Often in hand planting, the plants are set on the side of the furrow and an irrigation is given immediately following the planting of each row of plants.

Weather. Transplanting on days of adverse weather conditions, such as excessively high temperatures or strong winds, should be avoided if possible.

Starter Solutions. The addition of fertilizers to the transplanting water have shown little value in California except in a few localities of the Delta region. Here, starter solutions sometimes have given the plants a faster start and occasionally the yield at the first harvest has been increased slightly.

A two-row transplanter commonly used for large acreage. Two men work together to set the plants in each row. Water from the tank (about a quart for each plant) is applied to each individual plant as it is placed in the soil. Packers on the machine firm the soil round the roots.

An irrigation immediately following transplanting is often desirable, especially if the top 6 inches of soil is dry. In this field irrigation furrows have been opened close to the rows by small lister shovels attached to the rear end of the transplanter.

A suitable starting solution is 5 pounds of 16–20 ammonium sulfate-phosphate, or 1 gallon of a 10–10–5 liquid fertilizer in 100 gallons of transplanting water. The 16–20 material should be dissolved in a small container of water and then poured through a fine screen to remove the inert material. If mineral soils are quite dry at the time of transplanting there is some danger of the fertilizer burning the plants.

The use of plant hormones in planting water has shown no benefit.

Hot Caps. Hot caps are placed over plants at the time of transplanting, in some of the early market districts, when the plants are set out in February or early March. Hot caps trap some of the heat from the sun, thereby raising the temperature around the plants during the sunny days; protect against wind damage, and offer some protection against frost. However, hot capping is costly and usually will prove profitable only when the practice encourages early maturity.

PROTECTION FROM PESTS AFTER TRANSPLANTING

Darkling Ground Beetles attack plants the first few days after transplanting. Since this pest is very common in California, growers should carefully watch fields for its appearance. If this pest is suspected the base of the plants and the soil about them should be thoroughly dusted with hydrated lime the same day the plants are set out.

Flea Beetles and ***Cutworms*** sometimes cause damage in newly transplanted fields. If these pests appear, follow dusting program suggested for these pests in plant beds.

Wireworms. If a field has to be used that is known to be infested with wireworms, the infested portions might be fumigated with ethylene dibromide 2 or more weeks prior to planting. This treatment when used on some of the heavy soil types may seriously retard the growth of tomatoes unless a month or more is allowed between the treatment and planting. The use of lindane in the planting water has provided protection against wireworms in some field trials. A rate of 1 ounce of 25 per cent wettable lindane in 100 gallons of water with 1 to 2 pints of water applied per plant has given control of the worms. A higher dosage will often seriously damage the plants. Even with this light dosage, off-flavors may be imparted to the tomatoes and until more is known regarding this treatment, growers should proceed with *extreme caution.*

Lindane should not be used on canning tomatoes unless the approval of the canner has been obtained.

REPLANTING

Replanting of missing plants, if necessary, should be done as early as possible. Use good plants, do a good job of transplanting and provide protection against pests. On large operations it is often desirable to have a late plant bed to furnish replants rather than use left-over plants from earlier beds.

FIELD SEEDING

FIELD SEEDING OF CANNING TOMATOES

Direct seeding in the field has been tried in all of the major canning tomato districts during the past 3 years. Many of these experimental fields have compared very favorably with transplanted fields. The practice has been quite generally accepted in the Tracy-Patterson and several other areas of the state.

The methods and the risks involved in starting a crop by this practice are quite

different from transplanting methods. Growers contemplating changing to field seeding should proceed cautiously at first. The practice may not be suitable under certain conditions, or time may be needed to learn the precautions that must be taken.

ADVANTAGES OF FIELD SEEDING OVER TRANSPLANTING

1. Less likelihood of infection of diseases spread by handling or by insect vectors.
2. Reduces risk of introducing certain diseases or pests into clean fields.
3. Eliminates need of special plant bed and transplanting equipment.
4. Shortens time from seeding to harvest by 2 months.
5. Allows uninterrupted and natural growth of the plants.
6. Permits closer plant spacing in the field without additional cost.
7. Wireworms and darkling ground beetles may be less troublesome.
8. Small labor requirement up to thinning time.
9. Less costly if climatic and soil conditions develop favorably.

DISADVANTAGES OF FIELD SEEDING

1. Late frosts may be a hazard in certain years.
2. Weeds are more likely to be a serious problem.
3. Carefully leveled land is required, if furrow irrigation is to be used during the germination period.
4. May require careful irrigation of whole field for germination.
5. Danger of soil crusting after late rains.
6. Greater chance of tillage problems due to wet soil in early spring.
7. May require special tillage to obtain suitable seed bed.
8. May require early field dustings for pest control.
9. More seed is required per acre.

COMPARISON OF FIELD-SEEDED AND TRANSPLANTED PLANTINGS

Diseases. Tomato mosaic is usually less prevalent in field-seeded plantings. Limited observations indicate that diseases such as bacterial canker, spotted wilt and curly top often may be less prevalent with direct seeding. Plants infected with these diseases frequently can be eliminated at the time of thinning. Damping-off has been observed with field seeding but seldom has it given serious losses.

Insects. Although it is advisable to avoid wireworm-infested fields, this pest may be less troublesome on field-seeded than transplanted plantings.

In field seeding there are usually extra plants. Some may be injured by the wireworms, but often enough plants will be left to insure a stand.

In case reseeding becomes necessary because of wireworm feeding on the seed, the seed for replanting might be treated with lindane at the rate of ½ pound of the actual gamma isomer per 100 pounds of seed.

Darkling ground beetles and flea beetles have caused damage to field-seeded plants, but serious losses have seldom occurred when control measures were taken promptly.

On occasion, relatively light infestations of grasshoppers have been troublesome.

Plant Growth and Yields. Field-seeded plants, once they become established, are stocky and better able to withstand damage by strong winds. The plants root fast and grow vigorously from the middle of June on. The yields of field-seeded crops have varied widely but in general have compared favorably with comparable transplanted fields. Often a

high percentage of the crop is removed at the first picking but this may be due mainly to the close plant spacings that are generally used.

Costs. With field seeding, seed and weeding costs run higher than in the transplanted method and there is the extra operation of thinning. Also one or more irrigations to obtain good germination will add to the cost of field-seeded plantings. Under favorable conditions these costs may run less than the cost of growing plants and transplanting. However, if the fields become excessively weedy or for some reason reseeding is necessary, field seeding may be more expensive than transplanting.

LAND PREPARATION

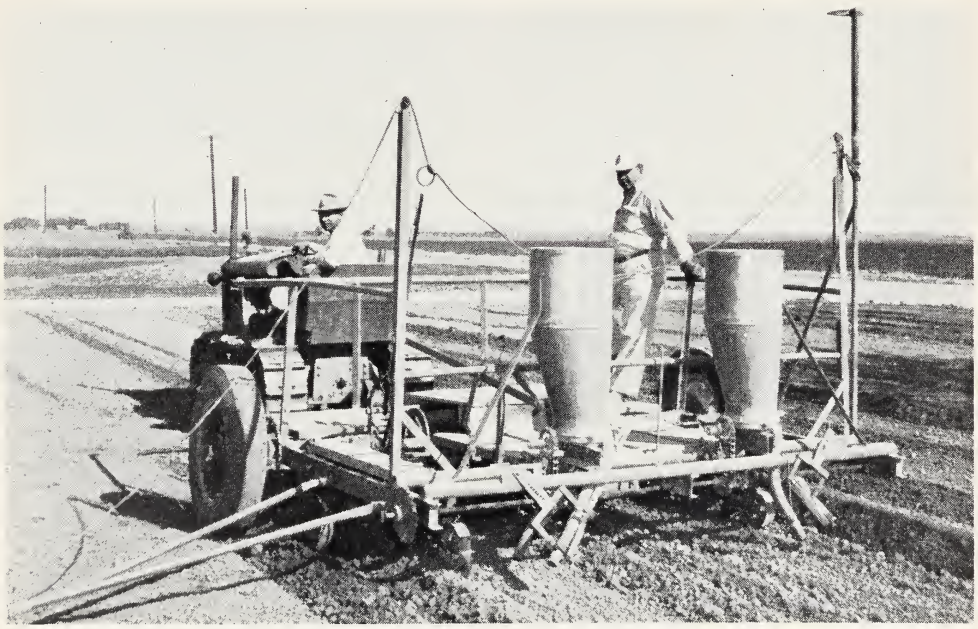
Preplanting tillage is similar to that of any other seeded crop. Fall disking or plowing may be advisable to hasten decomposition of any organic matter. Winter weeds should be controlled as necessary. Unless it is quite likely the seeds will germinate without an irrigation, shallow furrows or beds should be made just before planting. Conservation of the surface moisture is important so tillage in the spring should be as shallow and as limited as possible. If the use of pre-emergence weeding sprays is anticipated, the final preparation for seeding should be made 2 or more weeks prior to seeding.

In case the soil is quite dry at the time for seeding, it may be advisable to pre-irrigate the field rather than wait to supply the moisture after seeding. Pre-irrigation should be considered when the field has not been carefully leveled, and it is likely the seed can be germinated without additional irrigation.

PLANTING

Time. The most desirable seeding period for most areas appears to be between March 25 and April 15, although in 1948 some fields seeded as late as May 1 produced fair yields.

Plantings should not be made more



A two-row seeder unit developed in Stanislaus County for field seeding. The large hoppers are used to distribute dust or bait along the seed rows for pest control, or the dust is sometimes used to mark the rows for early cultivation work. See page 28 for close-up of drill.

than 2 weeks before the last probable frost.

Seed. Both regular and processed (coated) seed have been used for field seeding.

Regular seed usually gives better germination, and with proper adjustment of the seeder, a fairly good seeding rate can be obtained.

Coated seed used in a precision planter will permit more accurate seed placement, may reduce the amount of seed required and in some cases may reduce thinning costs. However, the coated seed is not as reliable as to germination, takes longer to germinate and seems to require better soil moisture conditions than unprocessed seed.

The cost per acre for seed is about the same, regardless of the type used.

If coated seed is used, make sure it has not been treated with mercury compounds before coating.

Drilling. The seed is drilled in rows 5 to 6 feet apart. The large Planet Jr. drill with No. 9 to No. 13 flat plates is commonly used for regular seed. Several other seeders have also proved satisfactory.

From ¼ to ⅓ pound of seed is used per acre. This gives 6 to 10 seeds per foot of row.

To give accurate spacing with processed seed, precision planters such as the John Deere No. 66, the Ventura or the Milton should be used. Coated seed spaced 4 per foot of row will require about ⅙ pound per acre.

The depth of planting, with either type of seed, will vary from ½ to 1 inch. Three-quarters of an inch is probably the best depth for planting.

The drills should be adjusted to firm the soil well around the seed.

CULTURAL PRACTICES AFTER PLANTING

Irrigation. Good moisture around the seed is essential during the germination period. If the soil is fairly moist at the time of planting, and good weather conditions prevail, the seed may germinate without additional irrigation. However, if the soil is dry at the time of planting, and a drying wind prevails during the germination period, one or two irrigations may be needed.

Sometimes an irrigation is needed to soften a hard crust on top of the soil that forms after a rain.

Plantings made late in March or in April will require 2 to 3 weeks to emerge.

After the plants have reached a height of 2 to 4 inches, it is often advisable to irrigate to replenish the moisture around the small roots and promote rapid growth. This is particularly important if no irrigation is provided during the germination period.

Weeding. Early weeding is usually accomplished by careful cultivation and hoeing by hand.

When weeds have germinated before the tomatoes, some growers have used light weed oils for pre-emergence spraying, with fair success. When this is done, the spray nozzles should be set to discharge at a rate of 60 to 75 gallons per acre. Since it is necessary to spray only a narrow strip along each seed row, only about 10 gallons of oil per acre will be required.

Oil sprays should be used with caution during warm weather, to avoid danger of injury to the tomato seedlings.

Some of the other chemicals used for pre-emergence spraying of other crops may injure tomatoes, particularly if a rain follows the application.

In some areas, the weeds will germinate and emerge about the same time as the tomatoes, thus eliminating the use of weed sprays.

Pests. If flea beetles, darkling ground beetles, or other pests become troublesome, the field should be dusted immediately with hydrated lime, DDT, or a combination of lime and calcium arsenate.

Close-up of drill and furrow opener on machine pictured on page 26. The furrow is for irrigating during the germination period or shortly thereafter. The seed is drilled close to one side of the furrow for better irrigation when plants are up. Photo courtesy E. E. Stevenson.

Chlordane has been found to be most effective in controlling grasshoppers.

THINNING

Thinning is done when the plants are 6 to 8 inches in height. For Pearson, the plants are left 15 to 24 inches apart but for varieties with larger vines, probably a spacing of 24 to 36 inches would be advisable. Vigorous, healthy plants should be selected and the rest thinned out. Long handled hoes are used for most of the work but with unprocessed seed some hand thinning may be necessary to leave all single plants. However, it does not appear to be serious if occasionally 2 or 3 plants are left close together.

After thinning, field-seeded plantings are managed the same as transplanted fields.

FIELD SEEDING FOR MARKET TOMATOES

Field seeding is practical for the fall market crop in areas under irrigation. Seeding should be done 2 to 3 weeks prior to the normal time for transplanting. The procedure outlined for the canning crop could be followed.

Aside from Coachella and Imperial valleys, this practice probably is not applicable for most of the early summer market crops, although it might be feasible in districts along the south coast.

In Coachella and Imperial valleys, the early spring crop is planted under paper protection and sometimes under hot caps. The seed is planted thickly in rows or in hills during late October or November. From ¾ to 1½ pounds of seed are used. The plants are thinned after the danger of frost is over, leaving the plants 18 to 24 inches apart in the rows. Usual row spacing is 6 feet.

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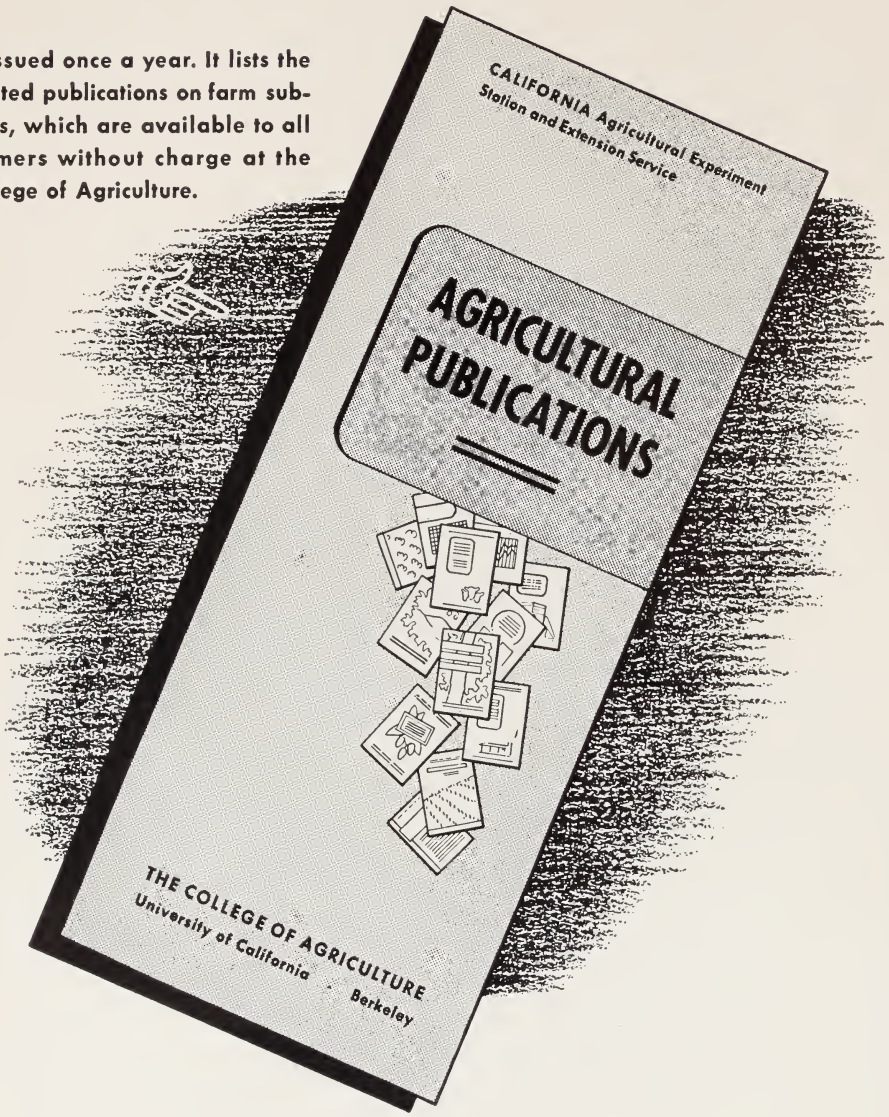

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